Evaluating Multiple Stressors in Loggerhead Sea Turtles: Developing: A Two-Sex Spatially Explicit Model.

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Project Goal

Our overall goal is to integrate the effects of multiple stressors into population models a basis for the evaluation of contemporary management alternatives for species conservation. We also plan to accommodate the spatial structure of the NW Atlantic loggerhead metapopulation. Our approach to wildlife risk assessment for migratory, long-lived species may subsequently be extended to other protected species.

Work Status

This project was initiated on Nov 15, 2001 when funds arrived. To date we have secured the necessary permits, collected historical life history and environmental risk data for each site, collected hatchling loggerhead sea turtles and are rearing them in the laboratory for determination of sex, and are conducting ongoing QA and QC. Progress on each item is summarized below. We made adjustments to the original schedule to accommodate revisions in our experimental design and strengthen our study. The design change we made was to collect the majority of the sex ratio data during 2002 so that we could start to build these initial data into our models. We added a collection of growth data so that we might better grasp the growth potential of these animals under controlled conditions. We shifted the study of hatchling survival in nearshore waters to year two of the study.

(1) **Data collection and preliminary analysis**

Southern subpopulation

Historical nesting beach data and, where available, in-water size class distributions and densities were collected from 6 Florida sites. The sampling duration of these data sets ranged from 8-20 years. Each provides significant baseline data for comparisons and incorporation into our model. For each site, the data set was sorted, reformatted and each record was examined for completion. Data managers for each site checked the reformatted data for accuracy. Survey years were compiled for efficiency. The databases were coded to allow exploration of associated metadata.

Boca Raton, FL (Gumbo Limbo Nature Center –Boca Raton) – Seasonal data have been collected 7 days per week (1989-2001), for an 8.33 km (5 miles) stretch of beach. Morning beach surveys were conducted from early April until late August or early September. All loggerhead nests were marked and excavated to determine hatching success and beach productivity. On average, Boca Raton contributed 63,643 hatchlings to the southern loggerhead population each year (mean =831 nests range 497 (1997) and 1075 nests (1990).

Juno Beach, FL (Marinelife Center of Juno Beach, Palm Beach County - DERM) – Surveys were done 7 days per week (since 1997) for 9 km (5.4 miles) of beach. Nesting density here is approximately 1000 nests/km. Each year Juno Beach contributes an average of 500,000 hatchlings to the southern population, based on excavation and nest success determination from 10% of their nests.

Melbourne Beach, FL (University of Central Florida) – For this site, both nesting data and turtle tagging (in-water and beach) data has been collected. We are awaiting clarification of some of the nesting data and in-water juvenile densities from this site. However, there is a mean of almost 15,000 nests per year along 34 km (20 miles) of beach averaging 440 nest/km.

Hutchinson Island, FL (Quantum Resources – Florida Power and Light, Ecological Associates) – Nest data have been collected 7days/week since 1981 (until present). On average, 6000 nests (density ~ 250 nests/km) are deposited here yearly. These nests contribute approximately 324,000 hatchlings to the southern population each year. In water densities are being calculated from nearly 20 years of records.

Sarasota, FL (Mote Marine Laboratory) – Data have been collected from 1987 -present for 20 km (12 miles) of beach. Surveys are conducted 7 days per week and all nests are marked for later excavation. Approximately 1900 nests are counted each year; and ~ 10% are surveyed for hatchling production assessment. Sarasota beaches contribute just over 101,000 hatchlings to the southern population.

Sanibel, FL (Sanibel – Captiva Conservation Foundation) – Data have been collected at this beach for 10 years (1992-2001). An average of 377 nests/year were laid along 22 km of beach. All were marked for later excavation. The Sanibel nests contribute approximately 32,000 hatchlings per year to the southern subpopulation.

Northern subpopulation

Nesting beach data were collected (by Duke University) from 4 northern population beaches (Cape Island, SC, Kiawah Island, SC, Wassaw Island, GA, and Cape Lookout, NC). Data for these beaches are undergoing summarization and entry into our database.

Loggerhead collection and results of laparoscopies

Post-hatchlings studied in this project are currently held at three separate sites. There are 474 post-hatchlings at the Duke Marine Laboratory in NC collected from Kiawah Island, SC, Cape Island, SC, Cape Lookout, NC, and Wassaw Island, GA. There are 600 post-hatchlings being held at the FAU holding facility in Boca Raton, FL. These were collected from Melbourne, Hutchinson Island, Juno Beach, Boca Raton and Miami Beach, FL. There are currently 163 hatchlings from Sarasota and Lee Counties at Mote Marine Laboratory in Sarasota, FL.

Dr. Wyneken performed 75 laparoscopies from October 18-21, 2002 at the Duke Marine Lab. These hatchlings were released in the Gulf Stream on November 8, 2002. Laparoscopies (n =103) have been performed at FAU as of November 5 and 55 have been released into the Gulf

Stream. At Mote Marine Laboratory 29 laparoscopies have been completed. Turtles must be held for at least 1 week following laparoscopy and 3 weeks if a biopsy is taken, hence the difference in the number of animals examined and released.

2) Personnel changes. Melissa Snover accepted a post-doctoral position at UC Santa Cruz in California and left the project in June. She maintains an advisory role with the project. All other personnel listed are still involved with the project.

3)Expenses to date have substantially exceeded budgeted amounts because the costs to successfully rear this number of turtles and unanticipated conditions and restrictions imposed by the permitting agencies resulted in significantly greater set-up, labor, veterinary, and food costs both FAU and Duke Marine Lab. Changes in the Year 1 budget are summarized in Appendix 1.

4) Data collection has followed the protocols set out in our proposal. The same personnel are responsible from beginning to end of each task. Data are collected using a double blind protocol to ensure accurate, unbiased results. Collected data are collected and entered then a technician and the PI check all data separately to ensure that it is consistent, complete and understandable. Back-up copies of data are maintained by technicians and PI at off-site locations.

These overall sex ratio results (2 M:3F northern and 3M:17F southern), if confirmed with more complete analysis, are unexpected. Given that these data derive from early season turtles, when sand temperatures are coolest, we expected sex ratios to be skew toward males, particularly in the northern population. What this suggests is that as we add data from late season turtles, the seasonal totals will be much more strongly skewed to female than previously expected.

Growth Summaries For Northern and Southern Subpopulations (Figure 1)
Turtles from the Florida beaches showed similar trends in growth during each sampling interval to date (e.g. early season vs. mid season. Interestingly, the animals hatching in the mid season slowed in their growth rates by the end of the second month. We are now trying to identify the factors that might account for this difference.

Hatchling Collections and Sex Ratio Data Through 5 Nov 2002

Nesting Beach Location	Total # of nests per beach	Total # of hatchlings per beach
Melbourne, Fl	11	110
Hutchinson Island, Fl	11	110
Juno Beach, Fl	11	109
Boca Raton, Fl	13	127
Miami Beach, Fl	12	120
Sarasota County, Fl	12	120
Lee County, Fl	6	60
Kiawah Island, SC	12	120
Cape Island, SC	13	130
Wassaw Island, GA	16	160
Cape Lookout, NC	9	90

	n	Male	Female
Northern Subpopulation	75	40%	60%
Southern Subpopulation	132	15%	85%

6) Planned activity for the subsequent reporting period.
Year 2: 15 November 2002 -14 November 2003. Collect hatchling additional sex ratios as dictated by Year 1 results. Determine hatching recruitment for year 2. Maintain data entry and work on model; conduct initial analyses. File permit renewal request for year 2. Hire field and data assistants; continue data collation and coordination with cooperating facilities and projects. Determine hatching recruitment for year 2. Draft manuscripts. Write a year 2 report.

7) At this time we are still collecting data. Some work on data analysis and modeling relevant to this project has already been completed. Other manuscripts, presentations, and student theses will be submitted when the research is complete. These are summarized in Appendix 2.

Appendix 1.

TOTAL PERSONNEL

- We budgeted $26,447 for year 1 but reallocated money so this category grew to $36,899.

This $10,457change was made because the housing and holding requirements imposed upon us forced us to hold each subset of turtles (120 animals per subset) for an additional 3 weeks minimum. This substantially increased labor costs.

- Fringe Benefits of $1,902 was budgeted for J. Wyneken, this benefits were not taken.

This money was left in personnel to help cover the $10,457 that was needed for additional research assistants.

TRAVEL

- Travel to nesting beaches required more that the initially planned for trips (46 trips have been made so far) We budgeted $ 4,338 for year 1 but reallocated money to cover the $5,338 required.

The additional trips were necessary because 3 weeks of rain in June resulted in marked nests being washed out so we had to mark new nests. Additionally, the on-site personnel at one site (Sanibel/Captiva) were physically incapable to locating the nests of making so we made two extra trips there to mark clutches for our study.

- Registration & Travel (Sea Turtle Symposium) $1,100 was budgeted, we spent none.

At the time of the symposium this spring wehad only historical data and were in the process of summarizing it, we reallocated $1000 of those funds to cover the travel to the field sites. $100 was allocated to personnel to help cover the added personnel costs.

TOTAL EQUIPMENT

- We budgeted $21,000 for equipment in year 1 and spent $6450

We purchased 10 temperature data loggers for the turtle nests (~$500). (We were able to borrow the remainder.) A computer plus peripherals were purchased for ~$1,900. We purchased two MDS

endoscopes, biopsy equipment and light sources. We did not purchase to more expense Storz scopes. In the two years that passed between the time we wrote the proposal and when we needed the equipment, the quality of other brands, (including MDS) of endoscopes increased dramatically. It was possible to purchase 2 very good endoscopes and biopsy equipment for about $4,650. The remaining $14,550 was applied to the elevated personnel, supply, and turtle housing costs (Mote Marine Lab) described below.

TOTAL SUPPLIES

- We budgeted $5,252 and spent $7440.

This $2,188 overrun was due to added costs for surgical instruments, substantial pools, full spectrum lights, plumbing modifications, and significantly more turtle food than originally planned (all part of the regulatory changes imposed upon the study). Additionally veterinary services were required. (Our permit conditions require full veterinary necropsy of any turtle moralities among the turtles receiving laparoscopy. Three turtles that received the procedure died). Some of the unused equipment money was used to cover these expenses.

TOTAL OTHER

- We budgeted $1000 and required $2,600.

The costs for housing the Florida West coast turtles went up significant because of the added holding time, space, and turtle food associated with changes imposed by the permit conditions. The $1600 difference was covered by some of the funds from the equipment money

TOTAL CONTRACTUAL SERVICES

- We budgeted $52,246 for Duke Marine Laboratory.

We have encumbered that amount. At the time this budget report is written we are awaiting the remaining quarterly invoice.

INDIRECT COSTS @ 25.5% of Personnel, supplies, $25,000 of subcontract, telephone, travel, space.

- We budgeted $16,814 and have paid $13,277.24 as of the time this report is written.

However not all encumbered money has been paid out as we await outstanding invoices from Duke, and for supplies and travel. This amount will exceed $16,814 by several hundred dollars because of the increase in personnel supplies and travel costs. The overrun will be drawn from the excess equipment funds.

TOTAL PROJECT COSTS

We budgeted $131,599 for this project. That amount has been spent or encumbered for purchases and expenses incurred during the first year that are yet to be reimbursed and/or invoiced.

Appendix 2.

Publications

Epperly, S.P., M.L.Snover, J. Braun-McNeill, W.N. Witzell, Craig A. Brown, L.A. Csuzdi, W.G. Teas, L.B. Crowder and R.A. Myers. 2001. Stock Assessment of loggerhead sea turtles of the western North Atlantic. pp. 3-61, IN:NMFS Southeast Fisheries Science Center NOAA Tech. Memo. NMFS-SEFSC-455.

Epperly, S.P., M.L. Snover and L.B. Crowder. 2001. Impact of the pelagic longline fishery on loggerhead sea turtles. pp. 170-200, IN:NMFS Southeast Fisheries Science Center NOAA Tech. Memo. NMFS-SEFSC-455.

Heppell, S.S., L.B. Crowder, D.T. Crouse, S.P. Epperly and N.B. Frazer. 2002. Population models of Atlantic loggerheads: Past, present, and future. Pp.000-000, IN: A. Bolton and B. Witherington (eds.) *Synopsis of the Biology and Conservation of Loggerhead Sea Turtles.* Smithsonian Institution Press (in press).

Crowder, L.B. 2003. Reversing the decline of sea turtles: Insights from life-history population models. In: D. Scavia (ed.) *Report on Ecological Forecasting*, NOAA (in press).

Heppell, S.S., M.J. Snover and L.B. Crowder. 2003. Sea turtle population ecology. Pp. 275-306. In: P.L. Lutz, J.A. Musick and J.Wyneken (eds.) *Biology of Sea Turtles, Volume II*. CRC Press (in press).

Papers presented

Epperly-Chester, S., M. Snover and L. Crowder. 2002. Impacts of the pelagic longline fishery on Atlantic loggerhead sea turtles. Contributed paper, Symposium on Sea Turtle Biology and Conservation, Miami, April.

Snover, M.L., S.P. Epperly-Chester and L.B. Crowder. 2002. Population model analysis for loggerhead sea turtles (*Caretta caretta*) from the northern nesting subpopulation in the United States. Contributed paper, Symposium on Sea Turtle Biology and Conservation, Miami, April.

D'Agrosa, C., D. Hyrenbach, G.Rilov and L.B. Crowder. 2002. Spatial analysis of bycatch in U.S. Atlantic and Hawaiian pelagic longline fisheries. Contributed paper, American Society of Limnology and Oceanography, Victoria, BC, June.

Hyrenbach, D., C. D'Agrosa, G.Rilov and L.B. Crowder. 2002. Sea turtle bycatch in the U.S. Pelagic longline fisheries: The significance of oceanic habitats and fishing practices. Contributed paper, American Society of Limnology and Oceanography, Victoria, BC, June.

Snover, M.L., S.P. Epperly, and L.B. Crowder. 2002. Population model analysis for loggerhead sea turtles (*Caretta caretta*) from the northern nesting population in the United States. Contributed paper, American Society of Limnology and Oceanography, Victoria, BC, June.

Figure 1A. Florida loggerhead growth rates. Nests southern Subpopulation from the West coast.

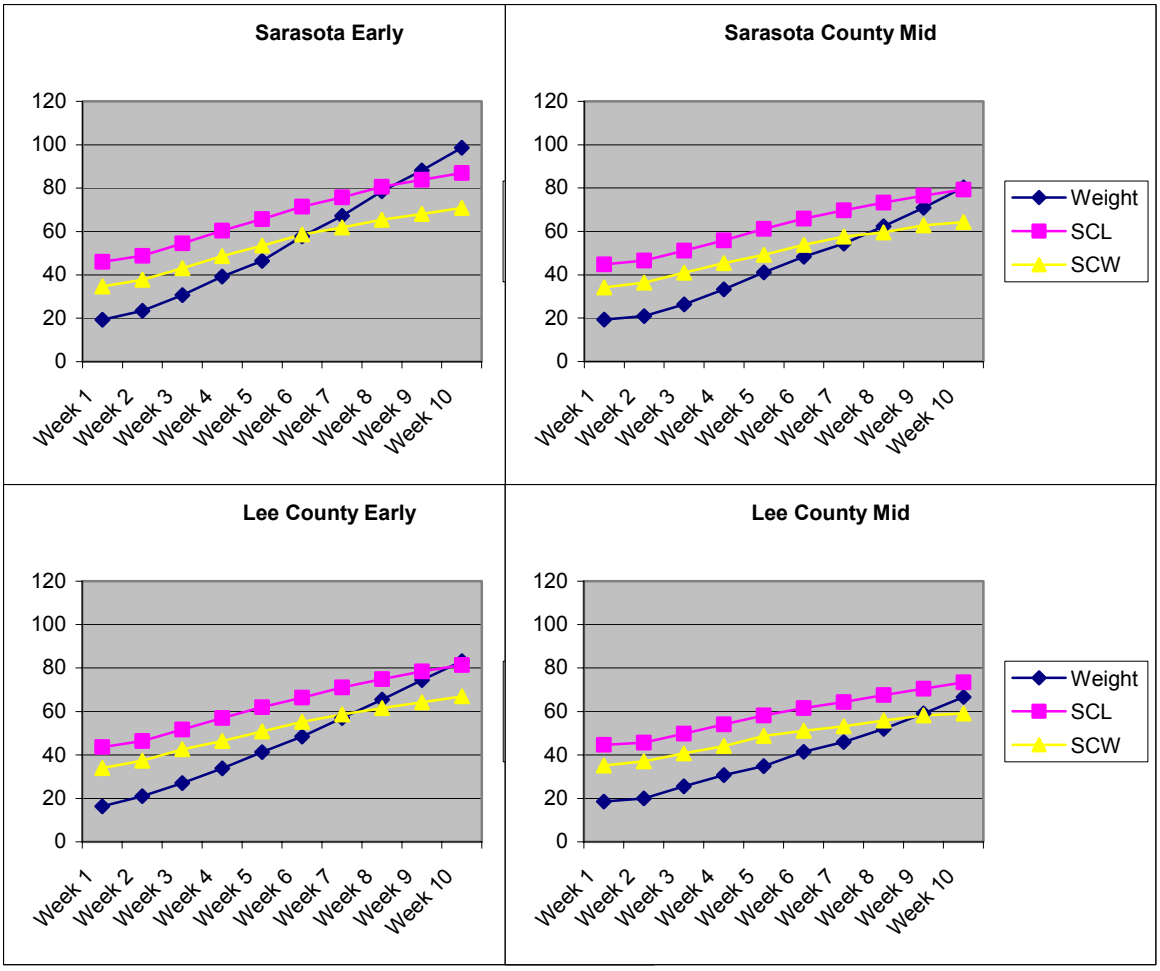
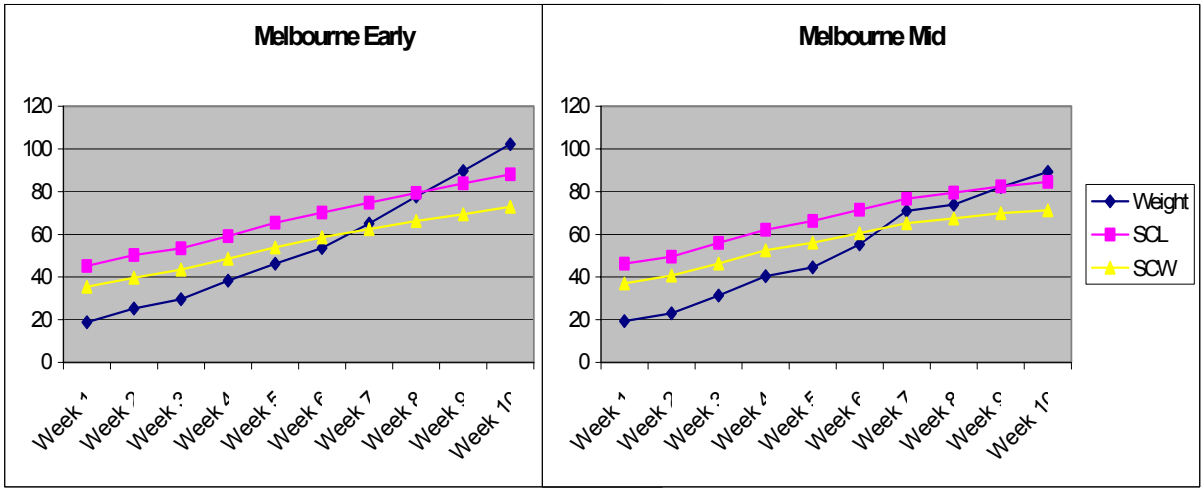


Figure 1 B. Growth of Loggerheads from the north-central Florida beaches.



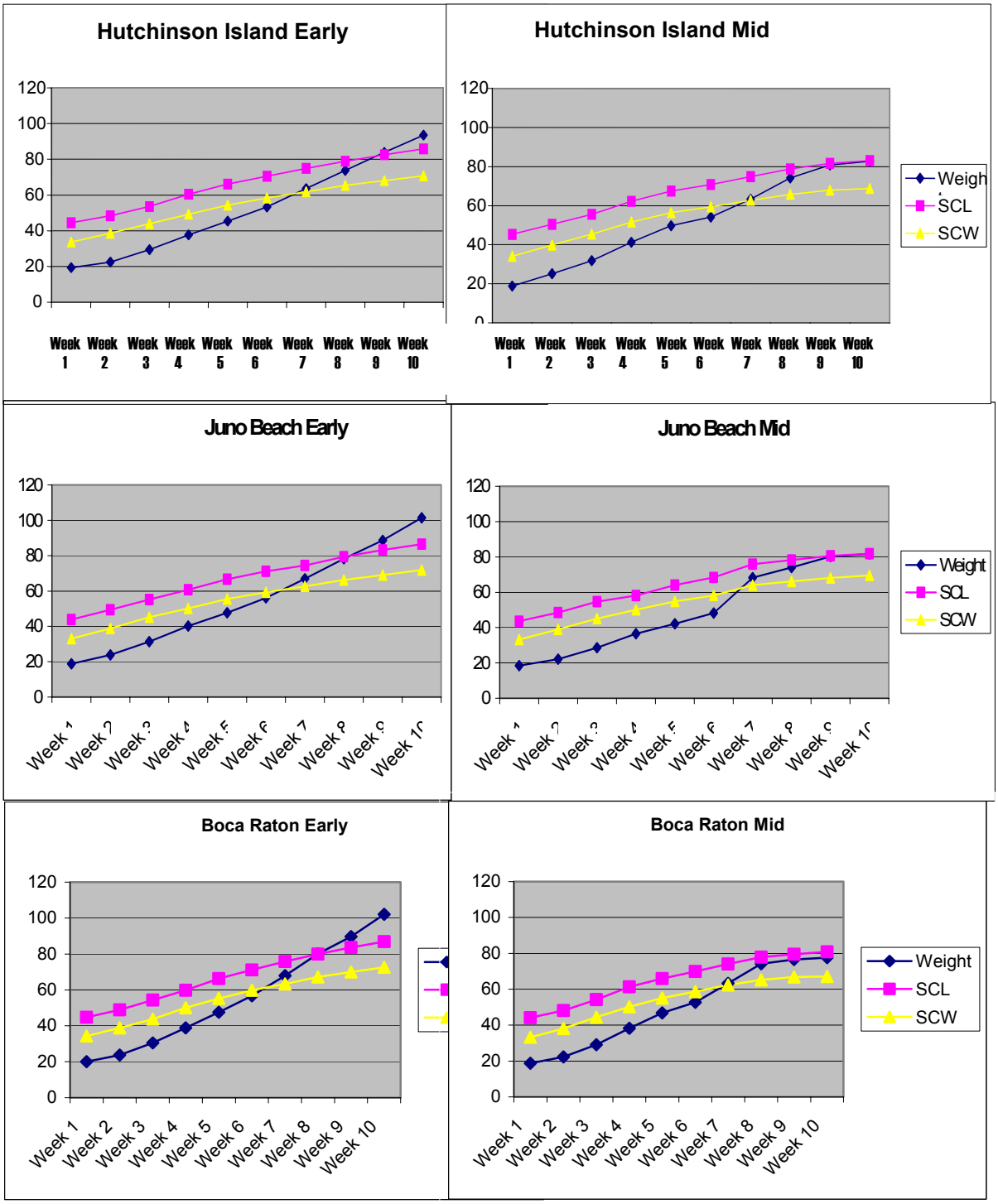

Hutchinson Island Early
120
100
80
60
40
20
0
Week 1
Week 2
Week 3
Week 4
Week 5
Week 6
Week 7
Week 8
Week 9
Week 10
Hutchinson Island Mid
Weight
SCL
SCW
Juno Beach Early
Juno Beach Mid
Weight
SCL
SCW
Boca Raton Early
Boca Raton Mid
Weight
SCL
SCW

Figure 1C. Growth Rates of loggerheads from the Northern subpopulation laid during the early and middle parts of the nesting season. These nests start hatching later in the season than those from the Florida (southern subpopulation). Carapace length (scl) and width (scw) growth appears similar to that of the southern subpopulation. Changes in weight around 7-10 weeks maybe more rapid, however data collection is incomplete at this time.